2.2 Projectiles

September 29, 2017 1:14 PM

General

- path is a parabola
- velocities broken into horizontal and vertical components
- horizontal, V_h, is constant
- vertical, V_v, change due to gravity acting
- for horizontal → $V = \frac{d}{t}$ (no acceleration involved)
- for vertical → uniform motion formulae:

$$d = V_{vo}t + \frac{1}{2}at^2$$

$$V_{vf}^2 = V_{vo}^2 + 2ad$$

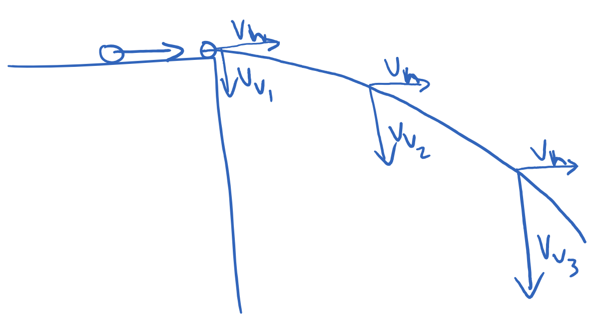
$$d = \frac{V_{vo} + V_{vf}}{2} \cdot t$$

$$V_{vf} = V_{vo} + at$$

$$\underbrace{\tfrac{1}{2}a}_{a}t^2 + \underbrace{V_{vo}}_{b}t \underbrace{-d}_{c} = 0$$

$$t = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Thrown Horizontally



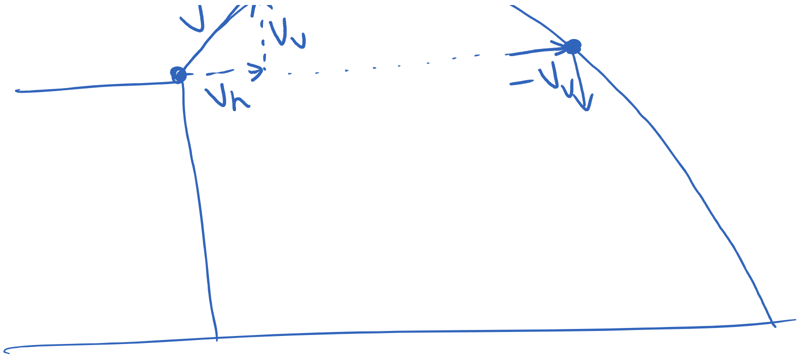
V_h remains the same

V_v increases as gravity accelerates it down

$V_{vo} = 0$ since only a horizontal speed was initially there.

Thrown at an angle

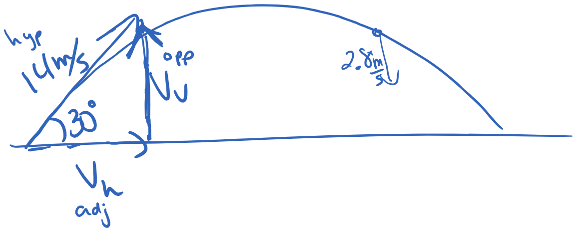
at the same height, the ball will have the same velocity, just opposite direction.



velocity, just opposite direction.

Example A ball is kicked at an angle of 30° from the horizontal. If its initial velocity is 14 m/s, what is the velocity 1.0 s later?

Solution



✓→ find $\vec{V}_h$ and $\vec{V}_{vo}$ from 14 m/s

→ use the $\vec{V}_{vo}$ to find $\vec{V}_{vf}$ after 1.0 s

→ combine $\vec{V}_h$ and $\vec{V}_{vf}$ to get V_f

$V_h = 14\cos 30° = 12.124\ \frac{m}{s}$

✱ $V_{vo} = 14\sin 30° = 7.0\ \frac{m}{s}$

$\vec{V}_{vf} = ?$

$\vec{V}_{vo} = 7.0\ m/s$

$\vec{a} = -9.8\ \frac{m}{s^2}$

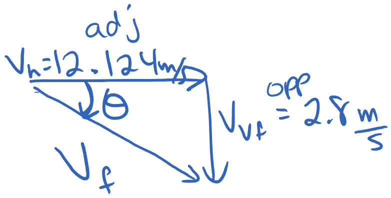
$t = 1.0\ s$

$\vec{V}_{vf} = \vec{V}_{vo} + \vec{a}t$

$= 7\ \frac{m}{s} + \left(-9.8\ \frac{m}{s^2}\right)(1.0\ s)$

$= -2.8\ \frac{m}{s}$ ← downward

recombine:



$V_f^2 = (12.124)^2 + (2.8)^2$

$V_f = 12\ \frac{m}{s}$

$\tan\theta = \frac{2.8}{12.124}$

$v_f = 12\frac{m}{s}$

$\tan\theta = \frac{2.8}{12.124}$

$\theta = 12.7°$

Ans: $v_f = 12\frac{m}{s}$ [13° down from horizontal]

W.B. example pg 57